

What is claimed is:

1. An apparatus, comprising:

a substrate;

an electrically conducting film deposited on said substrate, wherein said film is a metal other than Cr, or said film is a metallic alloy other than Cr-alloy when said substrate is Ge or Si, or a multilayered film which includes at least one metallic layer;

wherein said substrate consists essentially of a substrate material which forms a bond with said film; and

wherein said deposition is in at least a high vacuum environment.

2. An apparatus according to claim 1, wherein said substrate material is selected from the group consisting of Ge, Si, As, B, Bi, C, Ga, Se, Te, Fe, Al, W, Mo, Ta, Nb, V, Hf, Zr, Re, semiconducting compounds, halides, and co-deposited mixtures of incompatible systems.

3. An apparatus according to claim 2, wherein said film is a material selected from the group consisting of Mn, Ag, Fe, and Cu.

4. An apparatus according to claim 2, wherein said film is a material selected from the group consisting of Mn, Ag, Fe, Al, Au, Ni, Pd, Pt, Co, and their alloys.

5. An apparatus according to claim 2, further comprising an overlayer on said conducting film, wherein said overlayer is selected from the group consisting of Ge, Si, As, B, Bi, C, Ga, Se, Te, Fe, Al, W, Mo, Ta, Nb, V, Hf, Zr, Re, semiconducting compounds, halides, and co-deposited mixtures of incompatible systems.

6. An apparatus according to claim 1, wherein said film is a material selected from the group consisting of Mn, Ag, Fe, and Cu.

7. An apparatus according to claim 1, wherein said film is a material selected from the group consisting of Mn, Ag, Fe, Al, Au, Ni, Pd, Pt, Co, and their alloys.

8. An apparatus according to claim 1, wherein said film is less than about 0.2 nm thick and has an electrical resistance of less than 4×10^{-6} Ohm•m.
9. An apparatus according to claim 6, in which said substrate is less than 5 nm thick.
10. An apparatus according to claim 1, wherein said substrate material forms a metastable bond.
11. An apparatus according to claim 1, wherein said vacuum environment has a base pressure reduced to a value below 10^{-5} Torr.
12. An apparatus according to claim 1, wherein said vacuum environment has a base pressure reduced to a value below 10^{-6} Torr.
13. An apparatus according to claim 1, wherein said vacuum environment has a base pressure reduced to a value below 10^{-7} Torr.
14. A method for producing an electrically conducting ultra thin film with very low electrical resistance, comprising the steps of:
 - forming a substrate in at least a high vacuum environment wherein said substrate consists essentially of a substrate material which forms a bond with said film; and
 - depositing said film on said substrate in said at least a high vacuum environment without breaking vacuum between steps;
 - wherein said film is a metal other than Cr, or said film is a metallic alloy other than Cr-alloy when said substrate is Ge or Si, or a multilayered film which includes at least one metallic layer.
15. A method according to claim 14, wherein said substrate material is selected from the group consisting of Ge, Si, As, B, Bi, C, Ga, Se, Te, Fe, Al, W, Mo, Ta, Nb, V, Hf, Zr, Re, semiconducting compounds, halides, and co-deposited mixtures of incompatible systems.
16. A method according to claim 15, wherein said film is a material selected from the group consisting of Mn, Ag, Fe, and Cu.

17. A method according to claim 16, further comprising the step of depositing an overlayer on said film wherein said overlayer is selected from the group consisting of Ge, Si, As, B, Bi, C, Ga, Se, Te, Fe, Al, W, Mo, Ta, Nb, V, Hf, Zr, Re, semiconducting compounds, halides, and co-deposited mixtures of incompatible systems.
18. A method according to claim 15, wherein said film is a material selected from the group consisting of Mn, Ag, Fe, Al, Au, Ni, Pd, Pt, Co, and their alloys.
19. A method according to claim 14, wherein said film is a material selected from the group consisting of Mn, Ag, Fe, and Cu.
20. A method according to claim 14, wherein said film is a material selected from the group consisting of Mn, Ag, Fe, Al, Au, Ni, Pd, Pt, Co, and their alloys.
21. A method according to claim 14, wherein said film is less than about 0.2 nm thick and has an electrical resistance of less than 4×10^{-6} Ohm•m.
22. A method according to claim 14, wherein said substrate material forms a metastable bond.
23. A method according to claim 14, wherein said vacuum environment has a base pressure reduced to a value below 10^{-5} Torr.
24. A method according to claim 14, wherein said vacuum environment has a base pressure reduced to a value below 10^{-6} Torr.
25. A method according to claim 14, wherein said vacuum environment has a base pressure reduced to a value below 10^{-7} Torr.
26. A method according to claim 14, further comprising the step of treating said deposited film with heat.
27. A method according to claim 14, in which said substrate is less than 5 nm thick.
28. The product produced by the process of claim 14.

29. The product produced by the process of claim 18.
30. The product produced by the process of claim 26.
31. A method of reducing electromigration in a conductive film, comprising the steps of:
preparing a sequence of at least one adjacent layer on a top, at a bottom, and/or at at least one side of said conductive film in such a way that a total resistance at all interfaces between said conductive film and said at least one adjacent layer, and between pairs of any neighboring layers, is reduced to a lower level than otherwise exists between said conductive film and said at least one adjacent layer, and between pairs of any neighboring layers, thereby leading to reduced inelastic surface and interfacial electron scattering and with it to a reduction in electromigration;
wherein said conductive film is selected from the group consisting of pure metals and metal alloys, excluding Cr and Cr-alloys when on a Ge or Si substrate; and
wherein said at least one adjacent layer is selected from the group consisting of Ge, Si, As, B, Bi, C, Ga, Se, Te, Fe, Al, W, Mo, Ta, Nb, V, Hf, Zr, Re, semiconducting compounds, halides, and co-deposited mixtures of incompatible systems.
32. A method according to claim 31 in which said step of preparing includes the step of depositing said conductive film and said at least one adjacent layer in a vacuum environment consisting of at least a high vacuum environment.
33. A method according to claim 32 in which said step of preparing includes the step of treating said conductive film and said at least one adjacent layer with heat.
34. A method according to claim 31 in which said step of preparing includes the step of treating said conductive film and said at least one adjacent layer with heat.
35. A method according to claim 31 in which the step of preparing includes providing an outer layer which protects said conductive film from corrosion or oxidation.
36. A method according to claim 35 in which said step of preparing includes the step of depositing said conductive film, said at least one adjacent layer, and said outer layer in a vacuum environment consisting of at least a high vacuum environment.

37. A method according to claim 36 in which said step of preparing includes the step of treating said conductive film, said at least one adjacent layer, and said outer layer with heat.

38. A method according to claim 35 in which said step of preparing includes the step of treating said conductive film, said at least one adjacent layer, and said outer layer with heat.

39. A method according to claim 35, wherein said conducting film and said at least one adjacent layer is a multilayer film consisting of Mn-Ag-Mn-Ag-Mn-Ag-Mn-Ag layers, and wherein said outer layer is Ge.

40. A method according to claim 39, wherein said multilayer film is on a Ge substrate.